SUBJECT OUTLINE

1. Programme of study description

1.1.	THE "CAROL DAVILA" UNIVERSITY OF MEDICINE AND PHARMACY
1.2.	THE FACULTY OF MEDICINE
1.3.	DEPARTMENT I – FUNCTIONAL SCIENCES
1.4.	DISCIPLINE: BASICS OF PARACLINICAL INVESTIGATIONS
1.5.	DOMAIN OF STUDY: HEALTHCARE
1.6.	CYCLE OF STUDIES: BACHELOR'S DEGREE
1.7.	PROGRAMME OF STUDY: MEDICINE

2. Subject description

2.1.	Name of the subject in the study plan: Basics of Paraclinical Investigations				
2.2.	Subject code: DO I 13 S1M				
2.3.	Subject type (DF/DS/DC): DF				
2.4.	Subject status (DOB/DOP/DFA): DOB				
2.5.	Lecture tenured coordinator: Assoc. Prof. Dr. Adrian Iftime				
2.6.	Practicals/clinical rotations tenured coordinator: Assoc. Prof. Dr. Adrian Iftime				
2.7. Year of study	I	2.8. Semester	I	2.9. Evaluation type (E/C)	E

3. Total estimated time (hours/semester of teaching activity and individual study)

I. University training (teaching, practical application, evaluation)						
3.1. No hours per week	2	out of which:	3.2. lecture	1	3.3. seminar/ lab activity	1
3.4. Total hours in the study plan	28	out of which:	3.5. lecture	14	3.6. seminar/ lab activity	14
Evaluation (no. hours): 2						
II. Training/Individual study						
Time distribution						Hours
Study of the lecture material, of manuals, books, study of the minimal bibliography						18
Supplementary documentation in the library, documentation using the internet						3
Carrying out specific activities in preparation for the project, laboratory work, assignment preparation, reports						4
Preparation for presentations or tests, preparation for final exams						6
Consultations						1
Other activities						0
3.7. Total hours of individual study						28
3.9. Total hours per semester (3.4.+ 3.7.)			56			
3.10. Number of credits			2			

4. Prerequisites (where applicable)

4.1. of curriculum	None applicable

4.2. of competences	None applicable

5. Requirements (where applicable)

5.1. lecture requirements	Requires a lecture hall with computer assisted videoprojection and whiteboard with markers
5.2. seminar / lab activity requirements	Requires a lecture hall with computer assisted video-projection, laptop with specific software for medical simulations, laboratory equipment for demonstrations

6. Learning outcomes*

Knowledges	Aptitudes	Responsibility and autonomy
- Knowledge of physics laws involved in common medical and biological phenomena (correct measurement of arterial blood pressure through manual and automated methods, direct and indirect methods; bio-electrical phenomena and the ways these can be evaluated in clinical vs. research setting; the response of living tissues to ultrasounds - mechanical stress index and thermal stress index. - Knowledge of physical and mathematical limitations of ultrasound imaging techniques (resolution limit; differences between B-mode (morphologic), M-mode (motion), pulsed, Doppler and echo-contrast); the causes of imaging artifacts. - Knowledge of physical and mathematical limitations of X-Ray 2D and 3D imaging (projection problems; tomographic reconstruction algorithms; relationship between these and the total ionizing radiation dose; relationship between the resolution and the radiation dose. - Knowledge of the physical principles and usage of relatively new medical devices used in clinical practice (pulseoximeters, infrared thermometers, transcutaneous bilirubinometers), with an emphasis on understanding the limits and error domains of these devices.	- The development of critical thinking applied to medical sciences, through engaging in solving simple medical problems (appropriate for 1st year medical students): selecting an appropriate imaging method for particular conditions of the case. - The ability to correctly interpret results of blood pressure monitoring methods and the ability to spot and correct the sources of errors. - Applied critical thinking: - the ability to identify imaging artifacts arising due to reconstruction algorithms in a variety of physical imaging techniques (echography, digital radiography, tomography) - the ability to identify the sources of errors in the discussed paraclinical methods and the possible strategies to mitigate them.	- The ability to identify imaging artefacts from common paraclinical investigations (echography, clasical and digital RX, CT) The ability to self-check the validity of properties of electrical vector of the heart (found on ECG through geometrical vector analysis methods) -Identification of the objectives that are to be achieved, of the available resources, of the conditions needed to finalize them, of the working steps and working time -Development of a positive attitude regarding scientific research, understanding the reason for continuous research in the medical field

7. Subject learning objectives (correlated with the learning outcomes)

7.1. General learning objective	Para-clinical examinations are branches of laboratory medical sciences, which provide services for patients without direct involvement in care. This lecture offers a quick introduction in para-clinical methods that use Physics (pressure, ultrasound, bio-electricity, x-rays, gamma-rays, magnetic resonance). The lecture is designed to especially help the students that did not study Physics before enrolling in the medical faculty, providing concise definitions and explanations of the laws of physics involved in each lecture

	chapter. Lecture content was designed to answer most common questions addressed to Biophysics Department by the students in preclinical years (1...3), questions that are related to medical physics but are not present in the curricula of the main Biophysics Lecture.
7.2. Specific learning objectives	- Brings a simplified and clear understanding of key Physics concepts used by medical sciences. - The lecture was designed to be accessible and useful to the students that did not studied physics before the university; - Designed to develop the ability to self check the validity of some common measurements performed in medical practice. - Ability to perform a basic risk/benefit analysis of common paraclinical investigations.

8. Contents

8.1. Lecture	**Teaching methods**	**Observations**
Lecture 1. Hemodynamics and objective measurements of its parameters	Lectures are taught in lecture halls which are technically equipped for this purpose: laptop, video-projector. All lectures have an electronic support and are brought up to date from the point of view of the information, according to treatises, research journals and books. The lecture has an extensive additional multimedia support, available through UMFCD platform (medical animations, software for simulations, online access to educational resources).	The educational materials, according to the curriculum, are presented interactively using multimedia methods, power-point presentations, teaching videos, simulations. We use dedicated software simulators for CT reconstruction algorithms and 3D image generation.
Lecture 2. Recording of electrical signals from biological tissues		
Lecture 3. Electrical conduction in the body and in the heart		
Lecture 4. Ultrasounds and their medical applications		
Lecture 5. Medical ultrasound imaging methods (Physical principles, types, theoretical limits, artifacts)		
Lecture 6. Basic physics of 2D X-Ray imaging		
Lecture 7. Imaging in 3D (tomographic imaging)		

8.2. Laboratory / seminar (sem)	**Teaching methods**	**Observations**
Sem1: Introductive seminar (including work security). Standard and derived units for pressure used in medical practice (mmHg, cmH2O, torr, bar, psi, atm); problem solving: conversion between units.	Prezentare frontală cu întreaga grupă; metodă interactivă, expunere sistematică, conversație, problematizare, dezbatere. Seminarul beneficiază de un suport mulți media extensiv (animații medicale, acces online la resursele educaționale) și de suport software pentru simulare (augmentând demonstrațiile), astfel: - PhET Interactive Simulations (University of Colorado, Boulder); - KiG (KDE foundation Interactive Geometry); - CTSim (Open Source Computed Tomography Simulator); - Blender (Blender Foundation); - R (R Foundation for Statistical Computing)	During the seminars some fundamental physics notions will be recapped – these are necessary for understanding the physical principles underlying the function of the equipment in the Biophysics lab and the knowledge necessary for handling experimental data. The seminars are interactive and the students are encouraged to actively take part in them. During the practical activities, the students are presented with the physical principle that represents the basis of functioning of the device, including its mode of usage, the description of its component parts and the measurement to be done. Multimedia means and teaching movies are used. After obtaining the experimental data, students process them statistically and interpret
Sem2: Frequent errors in sphygmomanometric pressure measurements (examples, problems).		
Sem3: Measuring of membrane electrical potential (with digital simulation of the electrical field; patch-clamp simulation).		
Sem4: Finding the electrical vector of a tissue (heart, etc) from the scalar recordings (digital simulation with KiG software). Problem solving of a clinical case.		
Sem5. Photometric measurements in clinical practice (pulseoxymetry, infrared thermometry, transcutaneous bilirubinometry)		
Sem6: Measurement of heart rate and oxygen saturation rate (with portable pulseoxymeters).		
Sem7: Evaluation; recapitulation of main topics via applied problems.		

	Demonstrații practice se pot realiza cu aparate existente deja în dotarea disciplinei: sfigmomanometre, pulsoximetre, telemetre cu ultrasunete, ecograf portabil (aparate portabile care nu necesită precauții deosebite de protecția muncii), și în viitor cu aparate achiziționate special pentru acest scop.	them. A discussion of the experimental results is done, including their interpretation from the perspective of the biophysical mechanisms involved. Multiple choice exercises and applications of calculations regarding the topic of the practical activity are discussed. Medical applications correlated with the determined biophysical parameter are presented.

Bibliography for lecture and lab/seminars:

1. Alberts, B. *et al.*, ***Molecular Biology of the Cell***, 6th Edition, Garland Science **2020**, ISBN: 978-0-393-87094-7
2. Băran I, O. Călinescu, D. Ionescu, A. Iftime, C. Ganea, ***Curs de Biofizică***, Editura Universitară "Carol Davila" București, ISBN: 978-973-708-994-6, **2023**
3. Badea R., Dudea S., Mircea P., Stamatian F., ***Tratat de Ultrasonografie Clinică***, Ed.Medicală Buc., **2000**
4. Glasser R, ***Biophysics – An Introduction***, Springer, ISBN: 978-3642252112, **2012**
5. Goldberger A.L., *Basic principles of electrocardiographic interpretation*, UpToDate, Wolters Kluwer, **2024**
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7. Kaddoura S., ***Echo Made Eas***y, Elsevier, ISBN: 978-0702066566, **2016**
8. Kak A.C. and Malcolm Slaney, *Principles of Computerized Tomographic Imaging,* Society of Industrial and Applied Mathematics, **2001**
9. ***Lucrări practice de Biofizica si Fizica medicala***, coordonator A. Iftime, autori I. Băran, O. Călinescu, D. Ionescu și alții, Ed. Universitară Carol Davila, ISBN 978-973-708-710-2, **2013**
10. Malmivuo J., R. Plonsey, Bioelectromagnetism – Principles and applications of Bioelectric and Biomagnetic Fields, https://www.bem.fi/book/, Oxford University Press, 1995, updated **2014**
11. Nölting, B., ***Methods in Modern Biophysics***, 3rd Edition, Springer **2010**, ISBN 978-3-642-03022-2
12. *R*, R Core Team, R Foundation for Statistical Computing, Vienna, Austria, **2023**
13. Suslick, K.S., in Kirk-Othmer ***Encyclopedia of Chemical Technology***; 4th Ed. J. Wiley & Sons: New York, **1998**
14. United Nations Scientific Committee on the Effects of Atomic Radiation, ***Sources and Effects of Ionizing Radiation***, UNSCEAR 2019 Report to the General Assembly, with scientific annexes, actualizare **2022**
15. Prutkin J.M., *ECG Tutorial, Electrical components of the ECG*, UpToDate, Wolters Kluwer, **2024**
16. Iftime A. Fundamentele investigațiilor paraclinice - fișe de lucru individual (materiale didactice interne al disciplinei la UMF C.Davila, actualizate anual) **2024**

9. Assessment

Type of activity	9.1. Assessment criteria	9.2. Assessment methods	9.3. Assessment weighting within the final grade
9.4. Lecture	- The following will be graded: the exactness, accuracy and integrity of the knowledge; logical coherency; the degree of assimilation of the specialty terms; the capacity to operate with principles taught at the lecture.	Exam: **written, simple choice test** - The written exam consists of solving a simple choice test (each question has a single correct answer) made up of 30 questions, that are chosen to uniformly cover the topic studied. Distribution: 25 of the questions are from the lecture topics and 5 questions are problems from the seminars. - The test is identical in content for all the students in one exam entry, but the order of the questions is randomly varied. - The exam is considered to be	100%

<table>
<tr><td></td><td></td><td>passed if the student has correctly solved a minimum of 7 questions (the equivalent of grade “5”). The grading system is fully detailed below.</td><td></td></tr>
<tr><td>9.5. Seminar/ lab activity</td><td>The seminar activities (problem solving skills) are evaluated during the final written exam (above). At the given problems, only the correct answers are considered in the evaluation.</td><td>Additionally to the final written exam, there will be at least 2 home-works for auto-evaluation during the semester (to be used during the individual self study time). These will be evaluated, but not graded (they do not impact final grade). The students will receive feedback to improve their academic performance (if needed) during the semester, based on these home-works.</td><td></td></tr>
<tr><td></td><td colspan="3">The final grade is computed from the table below:
<table>
<tr><th>Final grade</th><th>Number of correct answers (from 30 maximum possible)</th></tr>
<tr><td>10 (ten)</td><td>30 … 26 correct answers</td></tr>
<tr><td>9 (nine)</td><td>25 … 21 correct answers</td></tr>
<tr><td>8 (eight)</td><td>20 … 16 correct answers</td></tr>
<tr><td>7 (seven)</td><td>15 … 12 correct answers</td></tr>
<tr><td>6 (six)</td><td>11 … 9 correct answers</td></tr>
<tr><td>5 (five)</td><td>8 … 7 correct answers</td></tr>
<tr><td>4 (four, exam failed)</td><td>6 … 0 correct answers</td></tr>
</table></td></tr>
<tr><td>9.5.1. Individual project</td><td>- not applicable</td><td>-</td><td>-</td></tr>
<tr><td colspan="4">9.6. Minimum performance standard</td></tr>
<tr><td colspan="4">• The written exam is considered passed if the student correctly answers at least 7 questions out of 30 maximum possible (i.e. > 20% out of maximum); this means that the student is able to at least recognize and minimally describe the phenomena studied during the lecture and seminar activities.</td></tr>
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Date of filing:	**Signature of the lecture tenured coordinator**	**Signature of the seminar tenured coordinator**
17.09.2025	Assoc. Prof. Dr. Adrian Iftime	Assoc. Prof. Dr. Adrian Iftime

Date of approval in the Council of the Department:

Signature of the Head of the Department

Prof. Univ. Dr. Ion Fulga